SCIENCE

FRIDAY, JULY 16, 1909

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

RESULTS VS. IDEALS IN TECHNICAL EDUCATION[1]

RESULTS *vs.* ideals; performance *vs.* promises; accomplishments *vs.* good resolutions; graduating classes *vs.* college catalogues and prospectuses—such is life!

This is a commemorative occasion; a twenty-fifth graduation; a proper time to look backward and revise educational estimates.

Chauncey Rose, the revered founder of Rose Polytechnic Institute, had very definite ideals. His thought was of an education blending the industrial sciences with advanced academic and even collegiate instruction; the product to be, not scholars only, but men fitted for various mechanical, professional and industrial pursuits; and equipped with both intelligence and skill.

The first president of Rose Polytechnic, the lamented Dr. Charles O. Thompson, came here with very practical ideals, worked out during fifteen years at what is now the Worcester Polytechnic Institute. He transplanted to Terre Haute the system by which adequate scholarship is joined to skill gained by manual training in shops and laboratories. The Russian system in Moscow was contemporaneous; but there all manual operations of shop-work were for instruction only; material was consumed, but for the products there was no use or commercial value. Professor Calvin M. Woodward, in St. Louis, had also worked ten years on the manual training system, in which he aimed to

[1] A memorial address on the occasion of the twenty-fifth graduation at Rose Polytechnic Institute.

teach tool-theory and mechanical analysis apart from ordinary shop-practise—to conduct a secondary school with a liberal course of study in mathematics, science and language. But the Worcester system developed by Thompson and Higgins gave shop training under commercial conditions; the saleable products had a widely recognized use and value.

In his inaugural address, President Thompson clearly set forth the purpose and scope of an institute of technology. He defined the term technology as the application of the sciences to industrial ends. He then deprecated the confusion of ideas which would apply the term, technical education, to *any* course of teaching which aims at a directly practical result, as opposed to the old academic idea of the "college education." But when, as he said, a title is sought for those who engage in the higher occupations or professions, the word technologist is found to be too vague and awkward; hence such men are termed engineers, and the business, engineering.

We may note here that the term "engineering" may seem to lack breadth of meaning, suggesting chiefly mechanical devices, engines, machine shops, etc. But reference to the dictionary will set us right; for the first definition (now obsolete) of engine is "natural capacity," "ability," "skill"; and the derivation is from the Latin *ingenium* which is a composite of *in* and the root of *gignere*, to produce. Hence the original sense is very comprehensive, and the word, as used, quite appropriate. Indeed, the late Geo. S. Morison, civil engineer, held that every engineering work is a tool for accomplishing some specific purpose; that engine is but another name for tool; that the business of an engineer relates to tools; that a civil engineer must be capable of designing as well as handling tools; that the highest development of tools is an engine which manufactures power; that we are in the early stages of a new epoch, that of the manufacture of power; that civil engineering in its true meaning embraces every special branch; that the true civil engineer must be able to design as well as direct; and that, whether he be a railroad builder, a skilful surveyor, a mechanical engineer, or devoted to any other specialty, he must be more than a skilful workman, he must be an originator, a creator.

In President Thompson's statement of the high purpose of Rose Polytechnic, he recognized this principle and emphasized it by announcing that the young men who propose to be civil engineers will spend part of their practise-time in the machine shop. This was then an unusual policy in the schools, but it accorded with the earliest precedents of the profession. The first great civil engineers of the modern world, Perronet in France and his contemporary, Smeaton in England, one hundred and fifty years ago, developed marked inventive power and skill along mechanical lines. They devised and adapted their rude auxiliary machines for constructive purposes. Instead of steam hoisting engines, they had only man power and horse power. Smeaton constructed and operated pumps, water wheels, blowing engines and windmills, and invented astronomical and meteorological instruments.

You may remember the familiar anecdote of Rennie who, when traveling, lost caste among his fellow passengers by mending the broken axle of a disabled stage-coach—but one offended companion was astonished to find him at the breakfast table of a nobleman next day.

To justify his ideals at that time, President Thompson reported, as the results of fifteen years' trial of the system, that more than 95 per cent. of the graduates at Wor-

cester were in occupations for which their training had specifically prepared them. The subsequent twenty-five years at Rose Polytechnic show that eighty-six per cent. have been and are devoted to pursuits relevant to the training received here—including electrical engineering and architecture, which have been added during the period.

But a world-wide view of the ever-expanding field of technical education shows some complexity; there is discordance of results and ideals; criticism is abroad. The president of a leading American university,[2] where science is the leading interest, has recently recognized a prevalent doubt whether scientific studies have the same educational value as the classical curriculum; whether they confer the same depth and breadth of intellectual power; whether the outlook they give is as wide, or the life as large, as that founded on the old college training. Cecil Rhodes, an Oxford man, a phenomenal man of affairs, and would-be empire builder, gave his answer by founding the Rhodes Scholarships. However, to say the least, such criticism is quite premature. The ancient order of education was a growth of centuries; the new is scarcely half a century old. The immense body of knowledge, with its useful applications developed by scientific inquiry during the past two centuries, has but little relation to the ancient learning based on literature, rhetoric and art. The old system produced and still produces too much ineffective culture.

It is almost beyond belief that two distinguished professors in great universities have openly declared that increase in the utility of studies makes them of less value in educating men; and that "The practical aim of a *general* education is such training as shall enable a man to devote his faculties to matters which of themselves do not interest him." One of our honored leaders has termed this "superb foolishness." The modern scientific training aims at efficiency. If there are defects, the remedy is not in going back to the old, but in making one reinforce the other; and in finding a right adjustment of all the complex terms involved.

Perhaps it was a sense of the growing complexity of the situation, and a need of some agency of adjustment, that led to the formation of the Society for the Promotion of Engineering Education in 1893. This is the first and, so far, the only society of its kind in the world—a national congress of the teachers of engineering. The choice of its title raised the old question, of education *versus* training. Warning was urged against the danger of putting too much emphasis upon mere training to the neglect of the broader education. Furthermore, was the purpose of the society more truly expressed by the word *technical* or by the adjective *engineering?* It was decided that engineering includes technical, in describing the professional endowment of the man; and that education includes training, as the whole includes the parts—without putting too much stress upon mere drill and manual dexterity. Dr. Calvin M. Woodward, of St. Louis, has well said that the watchword of engineering education is *service.* It is to be in itself essentially serviceable.

> The idea of service underlies every detail of it, and that service is objective, altruistic; and therein it differs from that older education whose supreme object is "culture." . . . We all know that there is more than one avenue to culture; in point of fact there are many avenues, and we purpose to claim for the accomplished engineer his right to full and equal membership in the increasing brotherhood of culture.

Indeed, the term profession, as a vocation, signifies the application of special

[2] President Remsen, of Johns Hopkins.

knowledge and skill for the use and benefit of others, and not for merely personal advantage. So that a so-called professional man whose sole aim is selfish gain is discredited. Hence the famous maxim of Smeaton reveals the true professional instinct of the engineer. He said: "The abilities of the individual are a debt which he owes to the common stock of public happiness."

Right here we may observe that the most practical product of culture for the engineer is literary ability. From the time of Smeaton's report on the Edystone lighthouse to the latest papers and articles in our technical publications, the writings of engineers lose nothing, but sometimes gain by comparison with other literature of like kind. Instead of creations of sentiment and fancy the engineer deals with plain facts and procedure; knows exactly what he wants to say; and is only concerned to express himself with brevity and effectiveness. His subject-matter almost naturally leads him to adopt the prime qualities of style. He may be classed with other scientists who, in the words of another, "have caught with remarkably close ear the accents of the English tongue."

Doubtless this ability must be cultivated; young graduates do not often have it, for they lack the first essential, that is, having something worth while to say. But they may, and ought to have the preliminary training derived from preparation of required reports on special topics, and the graduating thesis. And many older engineers might have more influence and better professional standing by judicious speech and writing. They hesitate to "speak out in meeting," when it is their duty to inform the community on questions of engineering in relation to public affairs. The late Mr. Eads was a forceful writer and speaker; otherwise he never would have persuaded Congress to authorize the construction of the Mississippi (South Pass) jetties against the opposition of those who advocated the ship canal.

Deficiency in this particular has prevented capable and worthy engineers from gaining proper recognition. So long as the majority of engineers are content to take the attitude and play the part merely of the "hired man," so long will capitalists, lawyers and politicians "run the business" and dictate terms to those who, by their special knowledge and skill, are entitled at least to equal voice in the council, and often to direction of affairs.

The society or congress referred to has appointed committees of investigation which have made extended inquiries and rendered reports; vital questions of general policy and methods have been discussed; and much attention given to details of courses and subjects of instruction. A very brief statement of some of their findings will make the present situation more apparent, and elucidate our theme.

1. *Entrance Requirements* were formulated by a committee which made the ideal too high. In mathematics, they included much of what is known as higher algebra, advanced trigonometry, and facility in use of logarithms; also a wide range of physics and chemistry and extensive work in modern languages. Here was manifest the influence of the extreme dictation of the colleges and universities to the secondary schools. The protest of the latter has become very loud, both in teachers' conventions and in current periodicals. Studies that belong in college, perhaps to the extent of half a year of time, are crowded back upon the high schools and academies, which can not properly do the work, both because of inadequate teaching force and immaturity of many of the scholars. A writer in a leading magazine for May has

charged the higher institutions with ruining the high schools by diverting their strength and chief endeavors from the many pupils who can not go to college to the few who can. He says the people, who build and maintain these schools at great expense, are being cheated out of their proper return by not getting the education best adapted to their needs. A few years ago, the speaker saw an examination paper for admission to our foremost university, requiring solution of a problem in organic chemistry, which the instructors at one academy said would be a hard nut for them, and would require considerable time and some laboratory work for a proper answer. Within two weeks a pertinent criticism, widely circulated, is to the effect that the money for public education should be more wisely spent; that a more consistent system should be built up from the primary grades to the high school; and that the school authorities should then say to the universities: "Adapt your requirements to our best boys and girls."

2. The question of specialization and too much diversity of degrees has received earnest attention. A committee reported that, in 1904, no less than 85 different kinds of engineering degrees were offered, 22 for post-graduate work and 63 for undergraduate. Among these were bachelor of arts in five branches, bachelor of engineering in four branches, plain bachelor in nine branches, bachelor of philosophy in five branches, bachelor of science in twenty-eight lines, including textile industry, sanitary and domestic science and naval architecture; railway, architectural, municipal and sanitary engineering; four doctors and four masters of different designations; seven masters of science in different lines of engineering, and nineteen others, including practical chemist, master of mechanic arts, irrigation engineer, marine engineer, chemical engineer, architect, civil engineer in architecture, architectural engineer, etc. Only twelve of the post-graduate degrees and only 47 of the undergraduate degrees were conferred—that is, about two thirds of all those offered. It would perhaps be unkind and inconsiderate to describe this as *absurd* variety; it certainly indicates hopeless diversity, not to say confusion of ideals. The writer has elsewhere urged that the titles master and doctor in engineering are superfluous, and that it is a mistake to depart from the simplicity and dignity of the titles: civil engineer, mechanical engineer, mining engineer, architect, chemist, or, if you please, consulting chemist, electrical engineer and, possibly, one or two more.

Thousands of graduates from engineering schools during fifty years have proved that men with thorough knowledge of the fundamentals find occupation in all branches of engineering, irrespective of the kind of *degree*. Yes, looking back a century, to the first forty years of the U. S. Military Academy, we find about fifty men (trained to be *military* engineers) becoming chief or resident engineers on the canals and railways built in that period. Among these was Major Whistler who built the railroad from St. Petersburg to Moscow, 400 miles, for the Russian government. Why then give men such distinctive and wordy labels, as though the school had cast them into molds, or already projected them with correct aim at definite targets?

3. On the question of *Graduation Requirements* the president of one of our older engineering schools protested strongly against the tendency to "the crowding of the curriculum"; another against too much attempt to anticipate for one who is yet a student, and whose future can not be dictated by overdoing between narrow limits. The committee on this vital topic

worked out a consensus of actual schedules which allowed 7,450 to 8,100 "hours" for 27 subjects, including language, mathematics, the physical sciences and seven differentiated lines of engineering. From this they prepared an essential curriculum, grouping preparatory studies and engineering subjects into four parallel columns, respectively, for civil, mechanical, mining and electrical engineers. This was for the usual four year course. But if requirements for admission are lowered to the extent of half a year, as just suggested, some four-year courses, as now arranged, must be curtailed at various points.

Hence many raise the point that four years is quite insufficient to fulfil a broad enough program of culture studies and the ideal requirements for graduation. Consequently a growing interest in the five-year or six-year curriculum. The experience of the speaker for more than thirty years has been with a two-year program of studies and practise exclusively in the line of civil engineering—but *preceded* at first by *four* years of preparatory work in college, which, during the last fifteen years, has been reduced to *three* years of collegiate work in language and science, including two years of graphics. The five-year course is about as long as the young man of average financial resources can undertake; and too long for many, who then resort to an intermediate year of actual practise, which always brings more than financial return to the student, in better appreciation of his studies. This question is still under discussion. Professor Perry, of London, has said recently, in correspondence: "May I suggest that you Americans are trying to do too much at college. You are trying to teach *everything* at an engineering college. It seems to me that a college ought to teach a man how to go on *educating himself* after he leaves college. . . . If this is the aim of a college, then a five or six year course is all too long." But the University of Michigan has recently announced a six-year course with three degrees in sequence: bachelor of science, bachelor of engineering and master of engineering.

And Harvard University, within a few weeks, has ceased to debate the question by separating her engineering school entirely from the collegiate or undergraduate courses and making it distinctly a graduate school. Harvard thus tardily recognizes engineering as a profession, on an equality with law, medicine and theology. The fact of such equality has long been evident enough. The practicians in the art of engineering have long levied tribute from widely diverse fields of scientific inquiry. They have profited from the labors of the mathematicians since the days of the Bernouillis and Descartes; only they have discarded mathematical abstractions and made mathematics available as a working tool. The engineers have directed the researches of chemists, metallurgists and biologists to useful ends in the operation of water-works, works of sanitation, rail-making, etc. They have made chemical and bacteriological laboratories a necessary adjunct in various works. A civil engineer vindicated the veracity of Herodotus (discredited by some scholars) by making actual survey of and identifying the margin of the (so-called mythical) lake Mœris, and revealing to the modern world the vast irrigation system of ancient Egypt; thus showing how the British administration of to-day has singular analogy to the policy of Prime Minister Joseph in the control of the irrigation by the government. A civil engineer of to-day rescued the manuscript of Frontinus from neglect by the scholars, and introduced that capable and painstaking water-commissioner of ancient Rome

to the acquaintance of his confrères, younger by nineteen centuries. This vocation, which thus derives both *interest* and *culture* with *utility* from so wide a range of science, archeology and classic literature, is this anything less than a profession?

Many other subjects have received the serious and constant attention of the society in the endeavor to establish practicable ideals; among them are: Instruction by non-resident lecturers and abuse of the method by lectures; disproportion between laboratory or shop-work and class-room instruction; mixing of preparatory subjects and those of the proper engineering program; waste of time by too much vacation; more work with the individual directly, rather than so much with the class as a whole; instruction in the biography and history of the profession; research laboratories and investigational work by engineering schools; engineering jurisprudence; relation of philosophy to engineering instruction; training for leadership; ought instructors to engage in professional work? and many other topics relating to details of class-work, text-books, methods, etc.

The mere mention of so many and such diverse questions of common interest shows the scope of our theme, but only in part. The relations of engineering schools to polytechnic *industrial* education are worthy of passing notice. The U. S. Commissioner of Education reported in 1907 more than 100 state universities, state colleges, institutions of technology, etc., having an attendance of 33,000 male students classified as studying technology, applied science and engineering. This includes some state colleges of agricultural and mechanic arts which might be termed semi-professional schools, as well as some of the technical institutes. Some are yet in their infancy; resources, clientele and other conditions are widely different. One has been inaugurated in an adjoining state within a month. These and the trade schools or secondary schools which distinctly give *training* for particular occupations are generally fulfilling their purpose, by opening the doors of opportunity to many who otherwise would have no hopeful outlook.

The late Professor J. B. Johnson called attention to the monotechnic schools of Germany which are supported by the state or by the municipalities, and have fine buildings and complete equipment of every appliance needed to prosecute each its appropriate industry; also to the hundreds of special schools, supported by trades and associations, which have abolished apprenticeship, and have thoroughly applied science to give exact training; with the result that the superiority of Germany in commerce, based on the growth of her great industries, has been achieved almost in a generation. The three years of study in the monotechnic schools follow two years in secondary scientific schools (*i. e.*, to include sophomore year in our grading), so that the five years produce scientifically trained *directors* of *industrial enterprises*. Again, the commercial colleges of France, Belgium and Germany are training men qualified by their special education to invade every quarter of the globe as commercial agents and builders of industries.

In the United States, the recent Nelson amendment to the Morrill Acts of 1862 and 1890 gives increased national aid for the extension and betterment of the work of the state colleges of agriculture and the mechanic arts. Several of the states are also giving increased aid, and the state of Illinois has taken the unprecedented action of appropriating $50,000 for the *graduate* department of its university. The latest

movement of a national scope was presented in the Davis Bill before the house committee on agriculture of the sixtieth congress. This proposed, among other things, to provide an appropriation for agricultural and industrial instruction in *secondary* schools. It is open to question whether the general government is not already overburdened by its generous annuities to the state colleges, and whether the action now proposed does not more properly belong to the states themselves; whether it is not too much national interference in state education. This brief survey of abundant and diverse opportunities for various education presents an apparently ideal situation; manual training and "domestic engineering" for immediate industrial use, through grades of the semi-professional to the highest type of technology. Yet many point to the results as entirely disappointing.

Only a few days ago was heard a scathing indictment of the state universities by a prominent manufacturer and large employer of labor in our great inter-ocean metropolis. He advised the states to go out of the "higher education business and send the boys back to their homes to help support the family, instead of being a heavy expense." He is reported as saying: "Instead of teaching young men to seek labor they cause them to despise it, and the students leave the schools with the feeling that they are too good to work, and smart enough to make their living by their wits."

This is an extreme view of a so-called "self-made" and self-educated man. Now your true self-made man is not to be described by the jibe of the cynic, as "one who quit work when half done and then began to brag of the job." Rather are they men of hard sense who have achieved wealth and influence in spite of deprivations; and they compel a respectful hearing. If we ask this hostile critic for specifications he might reply: The schools and colleges do not teach good manners; they do not enforce sufficient discipline; the moral suasion theory is so pushed that teachers are often deprived of the power of discipline; the worst scholars become insolent; that the school life, with its artificial conditions, is so far removed from the matter-of-fact world that scholars are not prepared to grapple with the problems of self-support; that many acquire bad habits and learn to be extravagant rather than thrifty; and that, considering the many who have gained wealth and influence without early advantages, the results from the lavish facilities of to-day are out of proportion to the cost.

Professor Johnson, in arguing for a higher and better industrial education, compared the German system with the great diversity of endeavor in American education as follows:

> The common schools give no special preparation for any kind of employment; the manual training schools likewise fit for nothing in particular; our engineering schools fit for very narrow lines of professional employment, and commonly educate men away from the industrial pursuits rather than towards them; and, as for our so-called commercial colleges, what do they teach beyond arithmetic, book-keeping, stenography and typewriting? Where then does the specific scientific training for the manufacturing and commercial industries come in? I submit that it does not come in at all; that our factories and business houses are largely managed by men of little or no scientific training, who have learned their crafts in the traditional way; who are, however, of an inventive turn of mind and who read the trade journals. They are a great credit to the system that has produced them, and many of them have become self-educated into an excellent state of efficiency; but as a class they are far from the ideal directors of such business, and very far indeed from the standard already achieved in Germany. Their success can in most cases be attributed to the extraordinary conditions offered by a

new and rapidly developing country rather than to any superior ability on their part.[3]

The president of another eastern university has been quoted as saying: "Men go to college now for association and sentiment. It is a four-years' playground." There may be some reference here to the obtrusive intercollegiate contests. On the *unpublished* college calendar the usual sequence is: football, basketball, dramatic performances, glee-club exhibitions, spring track-meets for athletics, "junior promenade" and various festivities, baseball, boat-racing and, lately, in the north, polo. This "traveling show business," in the name of institutions which stand for the highest learning and culture, has the concomitants of notorious betting and the expenditure of thousands of dollars in the traveling expenses of the loyal college "cheering squads." Thus the advantages of sports, allowable in moderation, are lost in wild extremes; thus these distractions from the legitimate work are constant throughout the year; thus some seem to regard this as their chief interest and make a business of play. We have the authentic reminiscence of a graduate of a leading New England university, who remarked at a class reunion: "We would have had a really glorious time here, if it hadn't been for those studies." This is no joke. In another college a professor found, on investigation, that the extraneous activities, such as society matters, college papers, and the various sports and recreations, most of them quite proper and even helpful in their place, might easily absorb all of the time, so as to entirely exclude the real work of the college.

However, we recognize a minority of students who hold aloof from this, in good degree, attend to their proper business, and save the scholarship of the institution. Blessed is the man who has no money for such dissipation; he is not as poor as he thinks he is. It is noteworthy, also, that students of technology are much less affected by this evil; possibly from the majority of technical institutes it is entirely absent; and the speaker may add that all who come under his jurisdiction have to renounce any connection with that sort of thing.

This looks like a strong case for the critics of higher education. But their view is so near sighted that they see only the flaws; their method would be that of the Turk; their cure the guillotine, their doctor the executioner. They overlook the fact that some of the most generous contributors to the cause of higher education have been and are of those who lacked its advantages and know its value. Moreover they fail to notice that this regrettable degeneration of college ideals is more especially among those who, if they have a definite aim, will say it is "general culture," or the uplift of what they term "college life." The representatives of technical education, on their own behalf, do not need to enter a plea of "not guilty," for they can show that schools of technology have saved and will save the situation, in large measure. Do they not supply definite aims and a vital interest in what they are doing? The practise in laboratory and shop brings both mental and manual capabilities into harmonious cooperation. When a man has been out all day or even half a day in field practise, and has his notes to put in shape and check, he has little inclination to go out to blow horns or make bonfires.

The president of Cornell University, only day before yesterday, practically took the same ground in replying to the adverse criticism.

[3] Proc. Soc. for Promotion of Eng. Education, Vol. VI., p. 27.

It is a platitude that the example of the technical schools has revolutionized the programs of the older colleges within a generation; and that their students are prompted to strenuous endeavor, such as is unusual among students in the general courses. Indeed, one college president has commonly said to young men about to enter the engineering courses that they are expected to do about a third more work than the other students.

Nevertheless, as we have already noticed, there is much questioning of results in and among the engineering schools, and doubtless room for improvement. Each institution has its peculiar situation and its own problem. The individuality, determined by past history, traditions, resources, equipment, specific aims, personnel of the instructors and acquired momentum, must persist. We can not entirely harmonize ideals or secure uniformity in results. But all schools and their teachers may share in certain practicable ideals and some possible results which we may term *characteristics* of the best technical education.

In this aspect of our subject we may premise a broader definition, to wit: *Technical education is a course of instruction (including suitable training) which will best prepare a man to adjust himself to his future opportunities in technical pursuits.* Usually the man can not choose as he would; only a few find ideal opportunities after graduation. Most men do not find themselves until they face the responsibilities of their vocation. Hence the unwisdom of trying to make choices (or elect) too closely within the jurisdiction of the school. There should be, above all, a readiness to face the *vicissitudes of choice* afterwards.

A *first* and indispensable *characteristic* is *thoroughness.* "Whatever is worth doing at all is worth doing well." If you say this is an admitted maxim of life in any business, we reply that it is *systematically* violated in the whole range of American education, from the bottom up. There is a woful lack of sanity in overdoing the schooling all along the line, and too little thoroughness anywhere.

We develop this characteristic by living up to certain principles of action. Among these we specify (*a*): *A man must check his work.* Here is a marked contrast to some literary training. It is not enough for the man to *suppose* results to be right, when he hands them in; he must *know* that they are right. In leveling, he must close on his benches within the allowed limit of error; in other surveys, he must close his circuits; in the shop, every piece of his work must pass the tests of the gauges. In the draughting room, every computation must be proved by himself or another, and every drawing verified by methods which he can apply for himself, so that he can confidently invite any scrutiny. Such training makes the man sure of himself, and develops the sense of personal responsibility. This is so elementary as almost to need no statement, yet right here has been much complaint from the practicians. They say that in the attempt to cover too much ground, the schools do not teach the men to do their work well; that the young graduate makes many mistakes; that he does not check his results; that he does not keep a neat note book, or have care enough to take sufficiently complete notes; that he is not sure of himself in use of instruments, and can not be trusted to go ahead without supervision. There is no excuse for this; such fundamental training is the business of the school; whatever else is done, this must not be left undone.

As a case in point, a young man, out of college for an intermediate year of prac-

tise, was ordered to run a line of levels. He declined to use the instrument given him, saying that he had tried to adjust it and found an inherent defect which would vitiate his work; and, as it was a line 125 miles long in a bad country, he could not be responsible for correct results. He was commended for his discretion, given a better instrument, completed the task, and before the end of the year was made assistant engineer with an office in a railroad center. You will say that this is only ordinary caution. True; but many fail at such a point. Others had heedlessly used that instrument without proving it, probably on the assumption that a level is a level, and must do the work in some way. Again, a young graduate on the reclamation service was marked for enforced vacation, when the contractors had failed and work was curtailed. But his chief said, "No, I want to keep him; somehow he always gets results and has them right!"

As tending to thoroughness also we may state as *principle* (*b*): "Do not have too many irons in the fire at once." For the average man in a professional course, about two subjects followed collaterally are enough to engage all of his interest and enthusiasm. This does not rule out one other for culture or relaxation, but that should be according to his own preference and at odd times. Any overburden tends to produce distraction and mental worry, which impair the average accomplishment. Dispersion of the stream in an alluvial channel makes shoal water, concentration makes deep water.

Working on this principle of concentration along two lines secures better *continuity* and more *sustained interest* in a given subject; also it makes more feasible the policy of *individual instruction,* by not restricting the sessions in class-room or laboratory to a set period of minutes or hours. The speaker has used for many years the half-day as a unit period, whether the assignments are for recitation, field-work or laboratory.

In this principle also is included the necessity of judiciously excluding all non-essentials. The body of engineering literature is now so overwhelming in its quantity and range that the most diligent student can only get a glimpse of it; but he can learn to use the indexes and make his own card catalogue, through required reports on assigned topics; also how to unlock the storehouse; how to make his knowledge and elementary skill effective in emergencies.

We have noticed how largely the engineering profession utilizes the results of a wide range of scientific investigation. This gives apparent complexity; hence the division into the several recognized branches. Yet it is no contradiction to assert that a *second characteristic* of engineering education is the domination of a comparatively few controlling principles and methods.

If the members of the graduating class will take a retrospect of their entire four-years' course they may be surprised to find how much it can be boiled down to a not very large residuum of fundamental principles and data. In the applications of mathematics the really important subjects of engineering employ chiefly the more simple rules, methods and formulæ of arithmetic, algebra, geometry (including the analytical), trigonometry and calculus. The more intricate formulæ and the higher theorems are not extensively used even in mechanics of materials, theory of framed structures and hydraulics. The interesting applications of the theory of the higher plane curves in mechanism and machine design are almost the poetry of mathematics. The entire science and method of the graphic statics is plain application of

such simple mechanics as the "polygon of forces" and theorems of moments; and these again are elementary propositions of geometry concerning parallelograms and laws of similar triangles.

Engineering instruction in all the leading institutions is usually differentiated into parallel courses only after the first, second or third half year, because they all stand on this common substructure of correct theory deduced from mathematical and physical laws. In the usual subjects or branches, such as concrete construction, bridges, buildings and arches, municipal engineering (including pavements and streets, sewerage and sanitation, water-supply, etc.), thermodynamics and heat-engines, electrical engineering, etc., each includes a body of special data and detail which may be studied by the student in some essential points, but can only be fully appreciated as applied when he becomes a practitioner. The speaker would urge that in the attempt to spread over so wide a range we may get too far away from our base; he would impress upon the student the ultimate unity and simplicity of the science and art of engineering in the large.

A hydraulic engineer of large practise in mill construction and power development says he is constantly reviewing his mechanics and other fundamental theory, so as to have always at instant command the principles which must be his guide to safe practise. Another, a successful inventor and mechanical engineer, says it has been his habit to read from one to two hours daily in physics, chemistry and electrotechnics, that he may keep posted, and work correctly in his laboratory. His fine library indicates scholarship and culture.

Enough said. We leave it to the student to take some simple principles like the theorems of moments, the law of the parabola or the principle of hydrostatic pressure, and trace them in their various applications throughout the range of engineering practise. For example, the simple principle of hydrostatic pressure so beautifully applied in the operation of bear-trap dams and automatic lock-gates—as on the Chicago drainage canal. The chief of the U. S. Engineer Corps has invented about fifteen forms of such dams and gates, some of which have been adopted with great success. The practicians are ever urging us to stick to the main principles and not attempt too much detail.

Other characteristics of the broad technical education might be specified, but we must pass on to consider what, by reasonable expectation, should be the *characteristics of the student, the graduate, the product.*

If we ask the officials of the schools, they would doubtless be nearly unanimous in claiming a rather good article. (Some years ago the recent graduates of a college of mechanical engineering were recommended to the U. S. government as competent to step in at once and operate the engines of the war vessels.) If we ask the young men themselves how they rate themselves —? Here General Horace Porter's advice to the cadets is apropos: Never under-rate yourself in action, nor over-rate yourself in a report.

"Men are born as ignorant as they ever were"; but, looking back forty years, we see vastly increased facilities for the earnest student of to-day: spacious and convenient buildings, well-equipped shops and laboratories and expansion of class-work and practise-courses. Also, in many institutions, the benefit of the advanced policy by which leading instructors are or have been practising engineers. Yet the conditions of the school must ever be artificial, at least in part, since they can not supply the acute sense of responsibility which goads a man on the works under an exacting chief.

What then are the practicable characteristics which we can specify for our graduate?

He may be a competent instrument man in all ordinary surveying operations, fitted to become a surveyor after due experience.

He may be a careful and accurate draftsman immediately available in the office, but not content to remain a mere draftsman many years.

If he is an exceptional man, with the right personal equation, he may be an acceptable inspector on works, but this usually requires some previous experience with men and affairs.

As a possible assistant to a city engineer he may have to act in either or all of these capacities during the first season.

He may be competent to take subordinate responsibilities as mechanical or electrical engineer or foreman.

In railroad work he must usually begin low down, but he is qualified to win rapid promotion.

Whether in these or other openings, if he is wise, he will consider himself only a beginner, an humble learner, ready to take lessons from foremen and laborers, on practical details. He will avoid manifesting self-conceit, and "*restrain* his little knowledge" until it is wanted; else he may get a snub from his chief which he will remember for a lifetime.

It is another platitude that many technical graduates find their way into other pursuits for which their studies have indirectly fitted them—such as contracting, executive positions, scientific agriculture, etc.; otherwise the number of institutions and graduates would be excessive. We may say, then, that *adaptation* often is and always should be a distinguishing characteristic of the competent graduate. At times when opportunities are not ready to hand, he ought to know how to "size up" the situation and go to work to make one. He may have to conduct a campaign, by interviewing, public speaking and writing, to educate possible clients or the public, as to the value or necessity of some public improvement or private enterprise. For the engineer always labors under the odium of one who spends other people's money. Happy is he if he is where such matters are decided upon their merits. Too often he will be opposed by political influence or private spite. He needs sound judgment, tact and determination to disarm opposition and push his work wisely.

Some months ago a graduate of eight years' standing wrote to the speaker that he was manager of water-works, etc., in a certain town in a state south of the Ohio; that he had made the surveys and estimates, organized the company, sold the stock, built a 25-million-gallon reservoir, with pumping station and electric lighting station as an adjunct, and had a $50,000 plant "running finely."

Our term "characteristic" indicates the most important quality of all—*character*. Some cynic has said that education is but a varnish or polish; "you silver scour a pewter dish, it will be pewter still." This half-truth is so far true that our human result must depend largely upon the antecedent conditions of inherited traits or disposition, and family training of the student. The constant action and reaction between student and instructors during four or five years has directed and controlled the professional growth. Given the right moral qualities in the man, there has been corresponding growth in character, producing integrity—wholeness. The nature and methods of engineering studies and practise promote this. In these threatening times of extravagance and corruption incorruptible honesty in purpose and action is urgently needed. If our graduate has courage to resist the tempter, even though he may lose present gain, he will

surely be in demand when men "find him out." If he has enough of the love of God he will have enough of the fear of God to put down the fear of man. Employers inquiring for graduates often say: "We don't care so much for great attainments or brilliant qualities; but we must have men whom we can absolutely trust."

In brief, the crowning characteristic is unqualified trustworthiness.

The level-headed graduate will not be misled by the familiar talk about "room at the top"; if he applies the theory of probabilities to himself he will correct that fallacy quickly. Few have their works known and seen of all men; most of us are "unpraised and unsung." But he will cherish the noble discontent which will ever spur him to high endeavor, and not permit him to cease from being a "growing man."

Rose Polytechnic Institute, through its able president and superior faculty, is working out the high ideals of its founder. It is showing its students that technical education is not the mere appropriation of a mass of information concerning theories, methods and results; but rather the selection of essential principles and data, and the coordination of these into a sequence of available knowledge. It reveals the accumulations of knowledge and teaches how and where to find what the man wants to know. Its practical instruction emphasizes and clinches correct theory, and makes not a present but a possible expert. It plants the germs, arouses the appetite, supplies the working principles, and teaches men to "think it out" for themselves; each graduate is a good deal of a scientist and something of an artisan, prepared to learn something about everything, and, if he lives long enough, to learn everything about something.

The greater results of the operations of nature's forces are accomplished by noiseless action, as with solar energy and many molecular transformations. James Watt, whose labors gave to the world all the potentialities of the steam engine, is said to have worked ever in quietness and contentment of spirit. *This higher institution*, this noble *instrumentality in the kingdom of God*, in the quietness of effectual working, has already sent forth an army of alumni. As another squad of well-drilled recruits goes forth to join the ranks (perhaps the spirit of the founder in some way observant) the "order of the day" displayed by alma mater is: Every man is expected to render full measure of duty and service, in doing the world's work in the fear of God.

Robert Fletcher
Dartmouth College

INTERNATIONAL EXCHANGE OF STUDENTS

An influential committee has been formed in Great Britain to promote international exchange of students between the universities of Great Britain, Canada and the United States. Lord Strathcona is president of the committee and among the vice-presidents are Lord Curzon, chancellor of the University of Oxford; Mr. Balfour, chancellor of the University of Edinburgh; the prime minister, the lord chancellor and other distinguished men, including a large representation of professors from the British universities. Committees have not been yet organized in the United States and Canada, but leading educators have promised their cooperation.

It is proposed to establish two students' traveling bureaus, one in New York and one in London; an American secretary (resident in New York) and a British secretary (resident in London), both of whom shall be college men appointed to afford every facility to any graduate or undergraduate of any university who wishes to visit the United States, Canada or the United Kingdom for the purpose of obtaining an insight into the student, national and industrial life of those countries.

The bureaus will undertake the work of providing information relating to United States, Canadian, British and other English-speaking universities for the use of students, undergraduates and others. They will also provide information relating to educational tours of any description in English-speaking countries, and the arrangement of tours suitable to the needs of the inquirer with a view to his obtaining the greatest facilities for education with a *minimum* of expense. Furthermore it will be their duty to provide information as to the best places for the study of educational, governmental, industrial and social problems in the United States, Canada and the United Kingdom, and other parts of the empire, as well as to provide introductions to leaders in the above-named spheres of activity, besides undertaking the organization and conduct of special tours for educational purposes, if necessary.

It is proposed to provide 28 traveling scholarships, 14 of these being available for universities in the United Kingdom, 10 for universities in America and 4 for universities in Canada. The arrangements will be controlled by general committees, one for the United Kingdom and one for Canada and the United States, unless it is found necessary to inaugurate a separate committee for each of the latter.

THE WINNIPEG MEETING OF THE BRITISH ASSOCIATION

SOME further announcements have been made in regard to the seventy-ninth annual meeting of the British Association for the Advancement of Science, to be held at Winnipeg from August 25 to September 1.

The inaugural meeting will be held on Wednesday, August 25, at 8.30 P.M., when Professor Sir J. J. Thomson, Sc.D., D.Sc., F.R.S., assumes the presidency, in succession to Mr. Francis Darwin, M.A., M.B., LL.D., F.R.S., and will deliver an address. On Thursday, August 26, at 8.30 P.M., the first evening discourse will be delivered by A. E. H. Tutton, M.A., D.Sc., F.R.S., on "The Seven Styles of Crystal Architecture." On Tuesday, August 31, at 8.30 P.M., the second evening discourse will be delivered by Professor W. A. Herdman, D.Sc., F.R.S., on "Our Food from the Waters." Lectures to the citizens of Winnipeg will be delivered in the Walker Theater by Professor Harold B. Dixon, M.A., F.R.S., on "The Chemistry of Flame," on Monday evening, August 30; and by Professor J. H. Poynting, D.Sc., F.R.S., on "The Pressure of Light," on Wednesday evening, September 1. The concluding meeting will be held in the legislative chamber, Parliament Building, on Wednesday, September 1, at 3 P.M.

Garden parties will be arranged on several afternoons during the meeting, including those given at the historic Lower Fort Garry by the commissioner of the Hudson's Bay Company and at the Provincial Agricultural College. Evening receptions are intended to be held by the Lieutenant-Governor at Government House and by the local executive committee.

Excursions will be arranged on Saturday, August 28, to points of interest in the vicinity of Winnipeg, including Stony Mountain and the municipal stone quarries; Lake Winnipeg, St. Andrew's Rapids and Selkirk; the wheat fields of Manitoba; the hydro-electric plant on the Winnipeg River. Members will also have the opportunity of visiting the following works in the city of Winnipeg: Canadian Pacific Railway shops and yards, Canadian Northern Railway shops, Grand Trunk Pacific Railway shops (under construction), Ogilvie flour mills, western Canada flour mills, municipal high-pressure plant and artesian well system.

An excursion will be arranged for mineralogists and geologists to the Cobalt district before the meeting. Headquarters for visitors at Cobalt will be at the office of Mr. A. A. Cole, Mining Engineer of the Temiskaming and Northern Ontario Railway and a program will be arranged for August 17 and 18. A visit to Sudbury is also contemplated after that to Cobalt. Further information may be obtained from Professor W. G. Miller, pro-

vincial geologist, Bureau of Mines, Toronto, Ontario; or from Mr. Cole.

An excursion of ten days after the meeting to the Rocky Mountains and the Pacific Coast is contemplated. Accommodation in the special train will be limited to 150 invited members, including 25 ladies.

Those proposing to attend the Winnipeg meeting can obtain from any railway ticket agent in eastern or western Canada a standard convention certificate which when properly validated in Winnipeg will enable them to return over the same route to the initial starting point without charge. Such certificates will be sold from August 16 to August 23 and will be valid for return until October 31. The fare from Quebec or Montreal to Winnipeg is $36.

It will be remembered that members of the American Association for the Advancement of Science will be admitted as full members of the British Association, for the Winnipeg meeting (and entitled to receive the volume of Proceedings), on payment of a fee of $5 (half the regular fee). It is important that those intending to be present should send in their names as soon as possible; printed matter bearing on the meeting will be gladly furnished by the local secretaries, the University of Manitoba, Winnipeg.

THE DARWIN CENTENARY AT CAMBRIDGE

The program of the commemoration began on the evening of June 22, when Lord Rayleigh, the chancellor of the university, welcomed to Cambridge the delegates, of whom there were two hundred and fifty, including thirty from the United States. On the following day addresses were presented by the delegates and speeches were made by the chancellor, Professor Hertwig, Professor Metchnikoff, Dr. Osborn and Sir E. Ray Lankester. In the afternoon there was a garden party at Christ's College, where Darwin was a student. There had been arranged there an extensive exhibition of portraits, manuscripts and other objects. To Christ's College the American delegates presented a bronze replica of the bust of Darwin by Mr. Couper, presented by the New York Academy of Sciences to the American Museum of Natural History. In the evening there was a dinner with addresses by Mr. Balfour and Professor Poulton. This was followed by a reception at Pembroke College. On Thursday honorary degrees were conferred on twenty-one delegates whose names have already been printed in Science and Sir Archibald Geikie, president of the Royal Society, gave the Rede lecture on Darwin as a geologist. In the afternoon there was a garden party at Trinity College given by members of the Darwin family.

SCIENTIFIC NOTES AND NEWS

Simon Newcomb, the great astronomer, born in Wallace, Nova Scotia, on March 12, 1835, died from cancer at his home in Washington in the early morning of July 11.

Among the honors awarded on the birthday of King Edward are knighthoods to Mr. Francis Galton, Professor J. Larmor, Mr. R. H. I. Palgrave and Professor T. E. Thorpe. Sir Dyce Duckworth and Mr. Henry Morris, president of the Royal College of Surgeons, received baronetcies; Dr. W. Schlich was appointed a Knight Commander of the Order of the Indian Empire (K.C.I.E.) and Mr. James Stuart has been made a privy councillor.

The University of Manchester has conferred its doctorate of science on Professor Theodore W. Richards, professor of chemistry at Harvard; Dr. Otto Wallach, professor of organic chemistry at Göttingen, and Professor Henry E. Armstrong, professor of chemistry in the City and Guilds of London Technical Institute.

In connection with the Darwin centenary celebrations Mr. Francis Darwin has been elected a foreign member of La Société Hollandaise des Sciences, Harlem, and a member of the American Philosophical Society, and Professor Sir George Darwin and Mr. Francis Darwin have been elected corresponding members of the Senckenbergische Naturforschende Gesellschaft, Frankfort, honorary members

of the Imperial Moscow Society of Naturalists, honorary members of the University of Moscow and members of the Kaiserliche Leopoldinisch-Carolinische Deutsche Akademie, Halle. The last-named academy was the first of foreign academies to honor Charles Darwin by making him a member in the year 1857. He was also a member of the Harlem, Philadelphia, Frankfort, Moscow and Halle Societies.

ON the occasion of the opening of the new surgical block of the Glasgow Royal Infirmary on June 23, a medallion portrait in bronze of Lord Lister was presented by the past and present members of the staff. The medallion is fixed on the wall opposite the entrance hall of the new block. The inscription on the framework records that Lord Lister was one of the surgeons of the Royal Infirmary from 1861 till 1869, and that in that institution he organized the antiseptic system of surgical treatment.

AT the meeting of the Physiological Society held at Oxford on June 26 Professor Gotch, who presided on the occasion, after a sympathetic speech, presented to Dr. Pavy, in commemoration of the eightieth anniversary of his birth, a silver bowl bearing the following inscription: "Frederick William Pavy, M.D., F.R.S., May 29th, 1909. From the Physiological Society, in token of affection and admiration."

A PAINTING by Mr. W. S. Kendall of Dr. T. M. Prudden, professor of pathology in Columbia University from 1882 to 1909, now emeritus professor, has been presented to the university by colleagues, students and other friends.

DR. J. MARK BALDWIN, professor of philosophy and psychology in the Johns Hopkins University, has resigned. Professor Baldwin has been attending the Darwin centenary at Cambridge, as the representative of the Johns Hopkins University and the Mexican Department of Public Instruction, and expects to remain abroad for some time.

MR. F. H. SEARES has resigned the position of professor of astronomy and director of the Laws Observatory of the University of Missouri. On August 1 he will become superintendent of the computing division of the Mount Wilson Solar Observatory of the Carnegie Institution.

DR. ALONZO S. MCDANIEL, who took the Ph.D. degree with physical chemistry as his major subject at Wisconsin last June, has been appointed chemist at the Bureau of Standards, Washington, D. C.

DR. MAZYCK P. RAVENEL, director of the State Hygienic Laboratory, Madison, will be placed at the head of the Wisconsin Pasteur Institute recently established in connection with the state laboratory.

MR. SINCLAIR WHITE, senior surgeon to the Royal Infirmary at Sheffield, has been elected president of the British Medical Association, to fill the vacancy caused by the death of Mr. Simeon Snell.

PROFESSOR ALBERT LADENBURG, director of the chemical laboratories at Breslau and known for his work in organic chemistry, is about to retire from active service.

DR. PAUL ASCHERSON, professor at Berlin, and eminent for his work on the geographical distribution of plants, has celebrated his seventy-first birthday.

DR. REID HUNT has gone abroad to attend, as representative of the Public Health Service, the International Congress on Alcoholism, London, July 18, and the International Medical Congress, Budapest, August 28.

DR. SPENCER TROTTER, professor of biology at Swarthmore College, has been granted leave of absence for the coming year. Dr. Trotter will study in the museums in Germany and France, and in the marine laboratories on the Mediterranean. Mr. Samuel Copeland Palmer, who has spent two years in the graduate school of Harvard University, will be acting professor of biology.

DR. JOHN A. MILLER, professor of mathematics and astronomy at Swarthmore College, is spending the summer at the Lick Observatory, measuring the photographs of the solar corona at that place. The new photographic telescope of nine inches aperture, the first

part of the astronomical equipment given to Swarthmore by Senator William C. Sproul, was installed this year in the new observatory provided for it. The observatory of Dorpat, Russia, has requested copies of the photographs of the Morehouse Comet, made on October 14, 15, 16 and 17, at the Sproul Observatory, Swarthmore College. These photographs will be published in the proceedings of the Russian observatory.

The sum of $8,000 required to purchase the home for the widow and children of the late Major Carroll has now been subscribed. The subscriptions came mainly from medical officers of the army and the Marine Hospital Service and from physicians.

Professor J. D. Cunningham, of the University of Edinburgh, eminent for his services to anatomy, has died at the age of fifty-nine years.

Dr. Wilhelm Zopf, professor of botany at Münster, has died at the age of sixty-two years.

The deaths are also announced of Mr. G. F. Beacon, a distinguished British civil engineer, and of Dr. Wilhelm Müller, professor of pathological anatomy at Jena.

The Congress has appropriated the sum of $25,000 for the expenses of the Congress of Hygiene and Demography, which is to be held in Washington next year.

A joint meeting of the International Scientific Association of Colonial Agriculture of Paris and the Society of Tropical Studies of Brussels, will take place in Paris on July 9, to make arrangements for holding the International Congress of Tropical and Colonial Planters and Experts interested in tropical agriculture, which will take place in Brussels in May, 1910.

The Gamma chapter of the honorary fraternity of Phi Lambda Upsilon has been established at Columbia. Membership is limited to chemists and chemical engineers in the faculty, graduates and advanced students.

The following addresses have been delivered at the regular monthly meetings of the Oregon Academy of Sciences: April meeting, "Cremation *vs.* Earth Burial," by Colonel A. W. Miller; May meeting, "Douglas Fir," by Dr. J. R. Cardwell; June meeting, "Alaska during the Klondike Rush," by Albert M. Grilley, illustrated by stereoptican views.

The wall maps, atlases and text-books, representative of many of the best appliances used for geographical education in Europe, which were collected last year by the American Geographical Society, are now on exhibition in the university summer schools of the middle west. The exhibition opened at the University of Wisconsin on April 15, at the University of Minnesota on June 4 and at the Ohio State University on June 21. The later exhibitions will open at the University of Chicago, June 15; Denison University, Granville, Ohio, September 15; University of Cincinnati, October 15; State Normal School of Michigan, Ypsilanti, November 24, and the University of Michigan, December 1. The University of California and Leland Stanford Junior University have secured the collection for dates not yet assigned and when it goes to the Pacific coast it will probably remain there for some time. Not a few teachers think that the collection will be especially helpful in the normal schools and it is expected that many of them will exhibit it. The material is loaned to any educational institution that desires it.

At a recent meeting of the County Schools Commissioners of Georgia, in convention at Tallulah Falls, June 29 and 30 and July 1, the subject of birds in their relation to agriculture was discussed, and it was decided to introduce the subject as a study into the common schools of the state. Professor R. J. H. DeLoach, of the University of Georgia College of Agriculture, was asked by the convention to prepare a bulletin on the subject, which is to be published by the state school commissioner and distributed, free of charge, to all school teachers in the state. Georgia is rich in bird life, both in summer and winter, and the teachers will be able with proper guidance to greatly strengthen the fight for bird protection in the state.

A forestry survey of the State of Illinois is now in progress under the joint auspices of the Illinois State Laboratory of Natural His-

tory and the United States Forest Service, which share equally in the expenses of the work. Engagements have been entered into which will bring the survey to a completion in 1910. Maps will be published showing the present and original distribution of forest areas in Illinois, and a report will be made, by counties, in detail, together with a description of the various types of forest, as to composition and condition, estimates of the standing timber in each county, means of maintaining the producing power of the forest lands of the state, and recommendations to private owners for the handling of their lands in a way to maintain and improve their forests.

AN Alabama Anthropological Society has been established. It is composed of twelve active members, residents of Montgomery, and of such associate and honorary members (an unlimited number) as may be hereafter elected. There are to be 12 meetings each year, each member submitting one paper. It is planned to issue from time to time publications of a scientific nature and a yearly bulletin containing the twelve papers submitted during the year. The first regular meeting will take place on July 22. The officers are: Thomas M. Owen, LL.D., president; Herbert B. Battle, Ph.D., vice-president; Peter A. Brannon, secretary; Buckner Beasley, treasurer.

UNIVERSITY AND EDUCATIONAL NEWS

MR. JOHN D. ROCKEFELLER has made a further gift of $10,000,000 to the General Education Board. Its endowment is now $53,000,000. Mr. Rockefeller has authorized the board to distribute the principal as well as the income for educational purposes should this at any future time appear to be advisable.

UNION COLLEGE has received $75,000 from Mrs. Katherine Spencer Leavitt, of Washington, for the endowment of the department of philosophy, the gift being in memory of her father, Rev. Dr. Spencer, of Brooklyn, N. Y., who was graduated from Union in 1824.

LORD STRATHCONA, Canadian high commissioner in London, has given half a million dollars to McGill University. Of this amount, $450,000 is to be used for completing the new medical building, and the balance for the augmentation of salaries of the faculty.

MESSRS. JOHN SWIRE AND SONS have promised a contribution of £30,000 towards the Hong Kong University endowment fund, the Taikoo Sugar Refining Company £5,000 and the Ocean Steamship Company £5,000, on condition that the whole amount required is subscribed.

THE University of Liverpool announces that the J. W. Garrett international fellowship in pathology and physiology of the value of £100 per annum, open to members of universities and medical schools in the United States, will be awarded in September. Applications should be addressed to the dean of the medical faculty, University of Liverpool.

DR. MILTON J. ROSENAU, director of the hygienic laboratories of the Public Health and Marine Hospital Service, has been appointed head of a newly established department of hygiene and preventive medicine in the Harvard Medical School.

PROFESSOR JULIUS STIEGLITZ, of the department of chemistry of the University of Chicago, has recently been made director of the laboratories of analytical chemistry in that institution.

STUDENTS who have been engaged in research work in the laboratory of physiological chemistry of Yale University and have received the degree of doctor of philosophy from the institution, have received appointments as follows: John Franklin Lyman, assistant professor agricultural chemistry, Ohio State University; Mary Davies Swartz, instructor in Teachers College, Columbia University; Israel S. Kleiner, demonstrator of physiological chemistry, medical department, of Tulane University; Warren W. Hilditch, instructor in physiological chemistry, Syracuse University; Victor C. Myers, adjunct professor of physiological chemistry, Albany Medical College; Arthur W. Dox, chemist, cheese investigations, Storrs Agricultural Experiment Station.

At Swarthmore College, Mr. Louis Fussell, instructor in electrical engineering and Mr. Ross W. Marriott, instructor in mathematics, have been promoted to assistant professorships. Mr. H. L. Ward, who has been assistant at Yale University, has been appointed instructor in chemistry.

Mr. George P. Paine, of Ripon College, has been made assistant professor of mathematics at the University of Minnesota.

Dr. Jonathan T. Rorer, of the Central High School, Philadelphia, has been called to the headship of the mathematical department of the new William Penn High School for Girls, of the same city.

The chair of botany at Birmingham, vacant by the retirement of Professor Hillhouse, has been filled by the appointment of Dr. G. S. West, who for the past four years has been lecturer in botany at the university.

Mr. James Colquhoun Irvine, Ph.D. (Leipzig), D.Sc. (St. Andrews), has been appointed to the chair of chemistry in the University of St. Andrews in place of Professor Purdie.

DISCUSSION AND CORRESPONDENCE

THE FUNDAMENTAL LAWS OF MATTER AND ENERGY

To the Editor of Science: In a late number of Science (April 23, 1909) Professor Speyers has raised some objections to the system of non-Newtonian mechanics which I recently published.[1] While some of these objections are due to misunderstanding of the method employed in developing the new system, others of an *a priori* character are based apparently upon a certain feeling of repugnance to the view that the velocity of light in vacuo possesses a unique significance, as the limit of all possible velocities in a material system. This feeling, which has been expressed by numerous critics of non-Newtonian mechanics, I should like to discuss briefly. I will take this opportunity also to present in a new and perhaps simpler way, the principles involved in the development of the new system of mechanics.

[1] *Technology Quarterly*, June, 1908; *Philosophical Magazine*, 16, 705.

We may base our whole argument merely upon four empirical laws, of which the first two are universally accepted and form an essential part of the foundation of physical science. The other two are more specific in character, but it is hardly likely that their validity will be questioned by any one.

The first is the law of conservation of mass. If a system gains in mass, its environment must lose in mass by the same amount.

The second law states that if the center of mass of a given system is at rest, it can not be set in motion except through the agency of an external force; in other words, if the center of mass of an *isolated* system is at rest, it will remain at rest.

The third law was deduced by Maxwell from electromagnetic principles, by Boltzmann from thermodynamics, and has been accurately verified experimentally by Nichols and Hull. It concerns the mechanical impulse experienced during the absorption or emission of light. If a body emits a beam of parallel light, it acquires momentum in the opposite direction and the momentum acquired is equal to E/V; where E is the quantity of energy emitted, and V is the velocity of light.

The fourth law has always been tacitly assumed and I name it here only to show with particularity the whole empirical basis upon which the system of non-Newtonian mechanics rests. This law states that if a body suffers a mere loss of energy through radiation, and if then the same amount of energy is returned to it by thermal conduction, or by an electric heater, or by friction, or in any other such way, the system will return to its original condition.

Let us now consider, isolated in space, a body at rest. For an instant this body emits a beam of parallel light directly away from its center of mass. As a consequence of the pressure of the emitted light, the body begins to move in the opposite direction, acquiring momentum which is equal to E/V, E being the energy of the small quantity of radiation which is now traveling away from the original center of mass of the system with a velocity V.

If the velocity acquired by the body is v

and its mass is now m', then according to the law stated above,

$$m'v = \frac{E}{V}. \qquad (1)$$

From our fundamental law concerning the center of mass, it is obvious that, when the body begins to move, some mass must move in the opposite direction in order to keep the center of mass in its original position. But since nothing is moving in this direction except the small quantity of radiant energy which was emitted, this radiant energy must itself possess a mass m which is to the mass m' inversely as the distances, at any instant, of m and m' from the original center of mass. These distances are proportional to the two velocities and thus,

$$\frac{m}{m'} = \frac{v}{V}. \qquad (2)$$

Combining equations (1) and (2) gives

$$m = \frac{E}{V^2}. \qquad (3)$$

Therefore a beam of light possesses a mass which is equal to its energy divided by the square of the velocity of light.

By the conservation law the mass associated with the radiant energy must come from the emitting body, the latter therefore loses mass in proportion to the energy it loses. On the other hand, if the same quantity of energy as was emitted is now returned to the body in some other way, say by thermal conduction, the original internal condition of the body being restored, it will regain its original mass. It is evident, therefore, that when a body gains energy in any way, it simultaneously gains mass according to the simple law

$$dm = \frac{dE}{V^2}. \qquad (4)$$

This equation connecting the mass of a body with its content of energy is the basic equation of non-Newtonian mechanics. From this the other theorems follow at once. Thus it is obvious that if a body in motion has more energy than one at rest, it must also have a greater mass. Hence, we are led directly, as shown in my paper, to the equation

$$\frac{m}{m_0} = \frac{1}{\sqrt{1 - \frac{v^2}{V^2}}}. \qquad (5)$$

where m is the mass of the body moving with velocity v, and m_0 is its mass at rest.

This is the only equation of non-Newtonian mechanics that has been subjected to a direct experimental test. In my paper attention was called to the general agreement between the demands of equation (5) and the experiments of Kaufmann on the mass of the rapidly moving β particles emitted by radium, but some of the differences between the observed and calculated values seemed to some scientists too great to ascribe to experimental error. However, this question is now definitely settled by the recent work of Bucherer,[2] who investigated the same problem by a more accurate method. His results on the change of mass with the velocity are in striking agreement with our equation.

Since therefore non-Newtonian mechanics is based solely upon laws which have been universally accepted, and has been further verified directly by this decisive experimental test, the new system seems to be upon a thoroughly secure experimental foundation.

It is evident in equation (5) that m approaches infinity when v approaches the velocity of light. Hence a body moving as fast as light would have infinite mass and infinite energy. This is the conclusion which to some scientists has seemed incredible. They suggest that if we had started with an observation on the pressure of sound instead of the pressure of light, we might have been led to the conclusion that the velocity of sound is the maximum possible velocity. Of course, if this idea could be substantiated, it would be a very efficient *reductio ad absurdum* of the method. As a matter of fact, however, if we apply to sound energy the kind of reasoning that we have applied to radiant energy, we are brought neither to an absurdity nor to any result which is not readily predicted from the elementary principles of mechanics.

It is not that we have decided in advance

[2] *Berichte Deutsch. physik. Gesell.*, 6, 688 (1908).

to ascribe to the velocity of light this unique position. Nature forces us to a conclusion and if this conclusion is incompatible with our preconceived opinions, it is the opinions that must be changed.

Not many years ago, it was supposed to be possible to increase both heat and cold without limit, but we no longer hope to attain any temperature below —273° C. To cool any body to the absolute zero would require an infinite amount of work. Now we find likewise that it would take infinite work to bring any body to the velocity of light, and just as —273° C. became recognized first as the lowest possible temperature, then as the lowest conceivable temperature, so we must not only regard 3×10^{10} centimenters per second as the highest possible velocity, but we must so change our present ideas that this shall be the *highest conceivable velocity* in a material system.

In closing I should like to modify one of the statements in my previous paper. It was there intimated that the equations of non-Newtonian mechanics offered a means of determining absolute motion through space. In a recent paper by Mr. Tolman and myself[3] it is shown, on the other hand, that these equations maintain their full validity no matter what point is arbitrarily chosen as a point of rest.

Gilbert N. Lewis

Research Laboratory of
Physical Chemistry,
Massachusetts Institute of Technology,
June 19, 1909

SOME TRENDS IN HIGHER EDUCATION

To the Editor of Science: I was very much interested in the article by Mr. Marx entitled "Some Trends in Higher Education," which appeared in the issue of Science of May 14. While I believe that such investigations are of value, it seems to me that this article and others of a like nature, which have been appearing recently, show the need for more accurate and reliable statistics relating to higher education. In the great majority of cases the writers have all too often been intimately acquainted with only one institution. They have realized that in the case of this institution, well known to them, allowance had to be made for the published statistics, but they have not shown equal generosity to those institutions concerning which they knew little or nothing, and have accepted all statistics at face value. All persons connected with universities know very well, for example, how little trust is to be placed in the average comparative tables regarding the total number of students at the various institutions of learning. Nearly every larger university, by means of due selection and suppression, has made out a good case at one time or another in the attempt to show that it is the largest university in this country. These methods savor very much of some of the advertising indulged in by insurance companies, but universities and those writing about them ought to have a somewhat more scientific standard.

Mr. Marx's article is not devoid of many of the faults to which I have alluded. To cite just one instance: take, for example, the last column of table 4 on page 784. This table is supposed to give the average salary per member of the instruction staff, but surely no one having an intelligent knowledge of higher education in America can suppose that the *average* salary per year at Johns Hopkins is $1,226, or at Northwestern $835, or at Minnesota $867, or at Toronto $881.

It is not surprising to find the most erroneous conceptions prevailing about the administration of our universities, when even a responsible paper like Science publishes figures such as these noted without further explanation. Such looseness of statement does great injustice to many an institution. In the College of Liberal Arts at Northwestern University, where the salaries average lower than they do in the professional schools of the same institution, the instruction staff consists of fifty-nine persons. Their salaries for the year 1909–10 will amount to $117,450. This is an average annual salary of almost $2,000 per individual. It is a fact that no teacher in the university, who is paid at all, receives for a year's work so small a sum as $835. The low-

[3] "The Principle of Relativity and Non-Newtonian Mechanics," *Proc. Amer. Acad.*, June, 1909.

est salaries paid are, I believe, $900 to one man, and $1,000 to several others.

How then could such an average as $835 be obtained at all? The explanation is simple. Northwestern University Medical School, by reason of its situation in the city of Chicago and in a section of the city where clinical material is very abundant, has a very large attendance, and the number of clinical professors, instructors, etc., is correspondingly large. According to what is almost the unbroken custom in this country, clinical instructors serve without pay, but since their income is not derived from the university at all, to count them in in computing an average salary is certainly a grave error.

I could show, I think, without much difficulty, that the statistics given for Harvard and several other of the institutions mentioned in the article in question are also entirely misleading without such explanations as Mr. Marx has seen proper to give in the case of the institution with which he happens to be connected.

In closing may I also protest against the slurring remark made about Temple College on page 784? I have never been connected in any shape, form or manner with this institution, nor have I had any friend who has been in attendance there. Still, I feel that it is no more than fair to inform Mr. Marx that this institution, situated in Philadelphia, is doing a very worthy work and certainly ought not to be referred to in the manner in which it was in the article in question.

WALTER LICHTENSTEIN
NORTHWESTERN UNIVERSITY LIBRARY

TO THE EDITOR OF SCIENCE: I have read Mr. Lichtenstein's letter with much interest and am grateful for the opportunity you so kindly offer me to comment on it. While my first feeling is that your correspondent's letter answers itself, the casual reader might draw the inference from silence on my part that the criticisms offered are sound and unanswerable.

The letter says: "Mr. Marx's article is not devoid of many of the faults to which I have alluded." Let us see what these enumerated faults are:

1. "This article and others of a like nature, which have been appearing recently, show the need for more accurate and reliable statistics relating to higher education." True. The writer would call attention to statements to this effect on page 783, column two, paragraph two; the last paragraph of page 784; and the latter part of column one and top of column two, page 787, of the original article.

If, however, the inference is meant to be drawn that the writer's data are inaccurate, he must beg for more specific criticism as he is prepared to demonstrate the indubitable authenticity of his data. To give the entire tabular data on which the charts are based and the authority for each item would require nearly as much space, however, as the original paper occupied. The sources include long series of annual catalogues, reports of presidents and treasurers, as well as personal communications from administrative officers. The same mail which brought the letter of your correspondent this morning, also brought one from the president of one of the large universities, who has known of this investigation for a year and a half and to whom the writer is indebted for valuable data, containing these words:

> Unfortunately a great majority of the articles on education are full of generalities based upon no special investigation, which really give no help to any one. In contrast with this you have carried on a very important comparative investigation in reference to facts as to actual tendencies.

Quotations in the same vein might be made from half a hundred letters received from similar authoritative sources. The men best acquainted with the facts best recognize the authenticity of the data compiled by the writer.

2. "In the great majority of the cases the writers have all too often been intimately acquainted with only one institution."

Is this one of the faults laid at Mr. Marx's door? If so, on what knowledge of facts is it based? The writer had the honor of contributing to the discussion of "The Condi-

tion and Needs of the University of California,"[1] and of preparing the "Report of the Committee on Salaries at Cornell."[2] These papers his critic may have seen, but what can he know of the writer's mass of correspondence and unpublished data, or of the duration and extent of his investigations?

3. "They have realized that in the case of this institution, well known to them, allowance had to be made for the published statistics, but they have not shown equal generosity to those institutions concerning which they knew little or nothing, and have accepted all statistics at face value." This broad charge very obviously refers to the writer's footnotes on page 784; but by what stretch of the imagination can these be interpreted as showing "generosity" to the institution he serves—figures which reduce the salary expenditure per student from $219 to $176.51, and the salary average from $2,500 to $1,500? These were obvious notes from other published data and the references were given.

4. "All persons connected with universities know very well for example, how little trust is to be placed in the average comparative tables regarding the total number of students at the various institutions of learning. Nearly every large university, by means of due selection and suppression, has made out a good case at one time or another in the attempt to show that it is the largest university in this country. These methods savor very much of some of the advertising indulged in by insurance companies, but universities and those writing about them ought to have a somewhat more scientific standard." So? Our critic "has a good eye. He can see a church by daylight." Specifically this can only refer to Table 4, page 784, a table compiled from data furnished, it is to be presumed, by the institutions themselves to the Carnegie Foundation and in the construction of which the writer's part was purely mechanical—dividing figures in one column by figures in another. He didn't even use his head for the purpose—he did it with a slide-rule. If the results of these divisions are not exactly what had been foreseen by those who furnished the data, the blame must not fall on the writer. If there is fraud by all means let it be weeded out. The plain truth is what we are after. If "such looseness of statement does great injustice to many an institution," *whose looseness of statement is it?* If "no one having an intelligent knowledge of higher education in America can suppose that the *average* salary per year at Johns Hopkins is $1,226, or at Northwestern $835, or at Minnesota $867, or at Toronto $881," then that person, if of average intelligence, must infer that the figures furnished by these institutions to the Carnegie Foundation lacked that element of accuracy and coherence which one might have a right to expect in data emanating from such sources.

Your correspondent intimates that he could show the Harvard statistics to be entirely misleading. In this case the sources of my data are so readily accessible to all that I will give them:

Chart 3. Data 1880–1904, President Eliot's Annual Report, 1904–5, p. 15. Additional points for 1876, 1905 and 1906 from catalogues.

Chart 8. Same report, pp. 18–19.

Chart 13. Same report, p. 15.

Charts 22 and 27. Data for 1904, same report, p. 345. (The average salary is there given as $1,570.) Data for 1907, Carnegie Foundation Bulletin No. 2, pp. 10–11. The only other Harvard statistics in the article are those of Table 4, p. 784, also from the Carnegie Bulletin, No. 2, pp. 10–11.

Where are these items at fault?

But this letter grows too long. Mr. Lichtenstein says the average salary computed for Northwestern is wrong because it includes men who get *nothing at all* for their services. Under the circumstances the argument is naïve. It reminds one of Sheridan's consoling remark to his very stout but rueful adversary in a duel: "To even things up we will draw two chalk-lines down you and

[1] *Trans. Commonwealth Club of Cal.*, October, 1907.

[2] *Cornell Alumni News*, May 6, 1908.

all my shots which hit outside them we sha'n't count." If we eliminate those who teach for nothing at all, why not disregard those who get less than a specified sum, say $1,500? It would make a still more favorable showing for the average. The writer must confess inability to follow his critic's logic in this.

The writer has no prejudice against Temple College. It may be doing the worthy work your correspondent vouches for. The writer's passing curiosity was aroused by the fact that it appears to provide for the needs of 2,343 students, and a teaching staff of 198, out of an entire annual expenditure of $72,895, and so he gave voice to it. When all the facts are known, it is quite possible that this institution may be found to have sounder standards than many another guilty of extravagant and ostentatious expenditures. The more light we can get on these points the better.

After all, your correspondent and the writer don't disagree on the main point at issue, namely, that honest and reliable statistics are vitally necessary. Only, the writer was laboring under the impression that, so far as concerned data not previously common property, he was supplying to a slight extent just that kind of accurate material. Assuredly he has made effort enough to have it so; his conscience acquits him on that score. And it will take rather more convincing proof than that offered by this correspondent to shake his faith in its value. GUIDO H. MARX

WARNING TO ZOOLOGISTS AND OTHERS

ZOOLOGISTS and geologists generally are warned that a clever swindler is making a canvass of the zoologists of New York, seeking money under false pretenses. He operates by claiming to be the "nephew" of some well-known scientist who is a personal friend of the intended victim; and the skill and thoroughness with which he prepares each case is fairly amazing. He knows thoroughly the scientific men of Washington, and especially those of the National Museum and the Cosmos Club.

In person he is tall (about 5 feet 10 inches), neatly and cleanly dressed, smoothly shaven and weighs about 170 pounds. He can instantly be recognized by his broad, flat face, small shifty eyes set widely apart, wide mouth, flabby lips and a long conspicuous row of upper teeth, all of them very evenly discolored by tobacco. When attempting to work his game, he laughs nervously fully half the time that he is talking.

If any intended victim of this man will hand him over to a policeman, I will very willingly arrange for witnesses to appear against him, for the purpose of landing him where he belongs. W. T. HORNADAY

NEW YORK ZOOLOGICAL PARK,
July 8, 1909

WE have also received the following statement from the secretary of the Smithsonian Institution: A man familiar with scientific men of Washington and New York, claiming to be a nephew of the secretary of the Smithsonian Institution, has recently been securing money as a personal loan from friends of the secretary upon false pretenses. The secretary has no such nephew; the man is a swindler. He may be described as follows: Tall and large, weight about 165 pounds; Eskimo-like face, smoothly shaven; mouth, wide; lips, flabby; long conspicuous row of upper teeth evenly discolored by tobacco; age about 35; carries head inclined to the right; laughs almost constantly while talking.

SCIENTIFIC BOOKS

Ethics. By JOHN DEWEY and JAMES H. TUFTS. New York, Henry Holt and Co. Pp. xiii + 618.

Characteristic phases of ethical study during the last twenty-five years are the interest shown in the history of morality and the attention given to social, economic and political questions. The works of Letourneau, Sutherland, Westermarck and Hobhouse are able examples of the fruitfulness of the genetic method in ethical science, while the books of Wundt, Paulsen and Bergemann combine with the historical and theoretical treatment a discussion of the larger social problems that are agitating the civilized peoples of to-day.

A noteworthy addition to this latter group of books on ethics is the volume written by Professors Dewey and Tufts. In its first part it examines the beginnings and growth of morality, describing certain aspects of group life and tracing the process of moral development in its general outlines, ending with specific illustrations of the process taken from the life of Israel, Greece and modern civilization. Part II., which represents Professor Dewey's contribution to the book, analyzes conduct on the inner personal side. It seeks to find the meaning of moral action (The Moral Situation, Problems of Moral Theory), discusses the typical answers which have been made to this question (Types of Moral Theory), tries to discover the principles underlying moral judgments and moral conduct (Conduct and Character, Happiness and Conduct, Happiness and Social Ends, Place of Reason in the Moral Life, Place of Duty in the Moral Life, Place of Self in the Moral Life), and ends with an examination of the fundamental virtues. Part III. is entitled The World of Action and studies conduct as action in society. The attention is here centered upon three phases of conduct which are of especial interest and importance: political rights and duties, the production, distribution and ownership of wealth, and the relations of domestic and family life (Social Organization and the Individual, Civil Society and the Political State, The Ethics of the Economic Life, Some Principles in the Economic Order, Unsettled Problems in the Economic Order, The Family).

The plan of the book is good. It is important that the student be made acquainted with the facts of moral life, with the moral ideas and practises of the race in their evolution, that he study the principles of morality, and finally that he receive some guidance in the application of this knowledge to the problems of individual and social life. It is not easy, however, to carry out so comprehensive a plan within the narrow limits of a single text-book. There is little wonder therefore that the reader should at times wish for a somewhat fuller treatment; so much matter is often compressed into a narrow compass that only a student already familiar with the subject can thoroughly appreciate it. This is particularly true of the chapter on the Hebrew Moral Development and the chapter on the Virtues. But as the bibliographies given at the end of each chapter are excellent, no person possessed of the reading habit need remain in darkness.

Another characteristic of modern ethics is its desire to do justice to the different ethical theories and movements which have divided thought and practice. In this respect too the book before us exemplifies the spirit of the times. Assuming as it does that there is some germ of truth in each one of the great schools, it seeks to make peace between them, choosing sanely that which is valuable in each. Thus in the consideration of the controversy between the "attitude theory" and the "result theory" the conclusion is reached that it is an error to split a voluntary act which is single and entire into two unrelated parts, "inner" and "outer," "motive" and "end." A "mere" motive which does not do anything, which makes nothing different, is not a genuine motive at all, and hence is not a voluntary act. Consequences which are not intended, which are not personally wanted and chosen and striven for, are no part of a voluntary act (p. 238). And as only voluntary acts are morally judged, "the appropriate subject-matter of moral judgment is the disposition of the person as manifested in the tendencies which cause certain consequences, rather than others, to be considered and esteemed—foreseen and desired. Disposition, motive, intent are then judged good or bad according to the consequences they tend to produce" (p. 262).

This would seem to be the correct solution of the conflict between the Kantians and the Utilitarians on this point. The question as to the *nature* of these consequences is handled in the same impartial way; we get another searching analysis of Utilitarianism and the opposing views, and an excellent criticism of psychological hedonism (chapters XIV., XV.). The net result of the discussion is:

(1) That happiness consists in the fulfillment in their appropriate objects (or the anticipation of such fulfillment) of the powers of the self manifested in desire, purposes, efforts; (2) true happiness consists in the satisfaction of those powers of the self which are of higher quality; (3) that the man of good character, the one in whom these powers are already active, is the judge, in the concrete, of happiness and misery (p. 280).

This view avoids the exaggerations of both hedonism and perfectionism; it shows also the influence of Professor Dewey's earlier idealistic training. But another question comes up here, and that is the time-honored controversy between individualism and universalism. And here too later Utilitarianism and German idealism join hands.

The genuinely moral person is one in whom the habit of regarding all capacities and habits of the self from the social standpoint is formed and active. Such an one forms his plans, regulates his desires, and hence performs his acts with reference to the effect they have upon the social groups of which he is a part (p. 298).

The true or final happiness of an individual lies not in the objective achievement of results, but in the supremacy within the character of an alert, sincere and persistent interest in those habits and institutions which forward common ends among men (p. 301).

Regard for the happiness of others means *regard for those conditions and objects which permit others freely to exercise their own powers from their own initiative, reflection and choice* (p. 302).

Moral worth consists in a readiness to regard the general happiness even against contrary promptings of personal comfort and gain (p. 364). This idea of the place of the self in the moral life is worked out in an interesting chapter XVIII., which discusses Self-Denial, Self-Assertion, Self-Love and Benevolence, and the Good as Self-Realization. The final word is that

The problem of morality is the formation, out of the body of original instinctive impulses which compose the natural self, of a voluntary self in which socialized desires and affections are dominant, and in which the last and controlling principle of deliberation is the love of the objects which will make this transformation possible. If we identify, as we must do, the interests of such a character with the virtues, we may say with Spinoza that happiness is not the reward of virtue, but is virtue itself (p. 397).

Morality, then, consists in the social attitude; the highest type of moral men consciously aim at the social good. This type is, according to Professor Tufts, the product of moral evolution; on the third level of conduct, the level of conscience, conduct is regulated by a standard which is both social and rational, and which is examined and criticized (p. 38). It is the stage of complete morality, which is reached "only when the individual recognizes the right or chooses the good freely, devotes himself heartily to its fulfillment, and seeks a progressive social development in which every member of society shall share" (p. 73). And

It is as true of progressive society as of stationary society, that the moral and the social are one. The virtues of the individual in a progressive society are more reflective, more critical, involve more exercise of comparison and selection, than in customary society. But they are just as socially conditioned in their origin and as socially directed in their manifestation (pp. 434 f.).

And it is this social standard that Professor Tufts applies in his sane discussions of the social, economic, political and domestic problems to which the last third of the book is devoted.

Persons of individualistic temperament will feel that the social element is somewhat exaggerated in these accounts. They may grant that the moral is the social in the sense that moral acts have to do with the ordering of social relations. And they may grant that the agent is moral when he strives for the social weal. But it may be questioned whether the social motive is the only moral motive, whether acts prompted by the sense of obligation or the love of virtue are non-moral. At the same time the rules of morality are largely social in their origin and purpose, and the social ideal is the guiding principle of moral evolution.

The book is a valuable addition to the many

able works on ethics that have been published in recent years and it is a credit to American scholarship.

Frank Thilly
Cornell University

Athletic Games in the Education of Women. By Gertrude Dudley, Director of the Women's Department of Physical Education, University of Chicago, and Frances A. Kellor, author of "Experimental Sociology," "Out of Work," etc. New York, Henry Holt & Co. Price $1.25 net.

Miss Dudley and Miss Kellor have presented a study which is unique, not only with reference to the influence of athletic sports and particularly team games upon women, but with reference to the nature and meaning of athletic sports themselves. The titles of the first three chapters are significant of this fact. They are: Citizenship and Social Education, Educational Value of Athletics, Instructors—their Responsibility and Training.

The plan of the book, after presenting these general sociological and pedagogical considerations, involves a discussion of athletics for girls as now carried on in secondary schools, colleges, universities and clubs. It involves also a discussion of the nature and effects of competition, and particularly of competition in public. The influence of games in promoting self-control, cooperation, fair play, loyalty, courage, responsibility, discipline, is discussed. The book takes up the matter of training in general and training specifically for basket ball, field hockey, etc.

The philosophical point of view taken is that the instinct feelings back of athletics are in the main those that make and control masculine character; that the ability to do team work is developed in the male by playing team games, such as baseball; and that modern woman, in her growing relationship to the community has need of these same elements of capacity for subordinating the self to the whole, of "playing the game," that a man gets through his athletics. The authors add: "These qualities are not essentially masculine. They are but human qualities, needed for human fellowship." There is frank recognition of the fact that the ethical element is secured only when the games are wisely conducted, and that too often only evil results are secured from badly managed athletics.

A question is raised in the mind of the reviewer as to the truth of the first assumption. Is woman really changing her relation to society? Is the present world-wide wave of unrest among women symptomatic of a permanent biological or sociological readjustment; and if such is the case, is the readjustment to come about through the social discipline of the female, by the same means through which the male has been disciplined? Are the social instinct feelings which have been so closely connected with woman's life —as far back as the ages of savagery—to be changed and developed into instinct feelings that tend toward the team spirit? The query is raised, but in the nature of the case it can not perhaps be answered, for it is easier to look back than to look forward.

Luther Halsey Gulick
New York,
June 15, 1909

Fishes of the Russian Empire and of Africa

A much-needed "Preliminary Synopsis of the Fishes of the Russian Empire" from a systematic and geographical point of view has been published by V. I. Gratzianow. It is dated on the title page, Moscow, 1907, but the copy in the Smithsonian Library was received April 3, 1909. The work is entirely in Russian and consequently will be of little use to most ichthyologists except for what may be gathered from the scientific names. The classification of Jordan is adopted mainly. 948 species are enumerated under 331 genera and 101 families. Dichotomous tables are given for the various groups.

The first volume of a "Catalogue of the Fresh-water Fishes of Africa in the British Museum (Natural History)," by George Albert Boulenger, has been published by the museum. It embraces the Selachians and the Teleostomes down to and including the Cyprinoid genera *Labeo, Discognathus* and *Varicorhinus.* Descriptions of all the species

and figures of almost all (270) are given. It is expected that the work will be completed in three volumes. An extended notice may be expected on the completion.

THEO. GILL

SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Experimental Zoology, Vol. VI., No. 3 (June, 1909) contains the following articles: "Studies on the Physiology of Reproduction in the Domestic Fowl—I., Regulation in the Morphogenetic Activity of the Oviduct," by Raymond Pearl. This paper describes a case in which a regulatory change in the shape of eggs successively laid by the same hen occurred, the change in shape following a logarithmic law. "The Physiology of Nematocysts," by O. C. Glaser and C. M. Sparrow. Experiments made on living nematocyst-bearing tissues as well as on artificially isolated nettling organs show that a rise in internal pressure brings about the discharge of the stinging thread; that osmotic pressure is responsible for the explosions of nematocysts in Eolids; that this may explain the similar processes among Cœlenterates; and finally that the nettling threads, contrary opinions notwithstanding, are capable of penetrating the tissues of other animals. "Observations on the Life History of *Tillina magna,*" by L. H. Gregory. A study of the morphology, physiology and methods of reproduction of the organisms, and its reactions to stimulations during different periods in the life history, with especial reference to the questions of artificial rejuvenescence and the inter-relations of nucleus and cytoplasm. "Studies of Tissue Growth—II., Functional Activity, Form Regulation, Level of the Cut and Degree of Injury as Factors in Determining the Rate of Regeneration—The Reaction of Regenerating Tissue on the Old Body," by Charles R. Stockard. The rate of regeneration in the medusa, *Cassiopea,* is independent of functional activity; form regulation inhibits growth; and the level of the cut determines the rate of regeneration in many species. The degree of injury does not exert the same influence over the rate of regeneration in all species; the new tissue has an excessive capacity for the absorption of nutriment even to the detriment of the old body.

SPECIAL ARTICLES

ON THE RESTORATION OF SKELETONS OF FOSSIL VERTEBRATES

IN a paper published last October[1] the writer, in referring to the mounted carnivorous dinosaur in the American Museum of Natural History supposed to be *Allosaurus* or *Creosaurus,* compared its hands with those of Marsh's restoration of *Allosaurus.* Inasmuch as the hands of the New York specimen are wholly artificial and those of Marsh's figure mostly or wholly so, it will be seen that the comparison was of something less than no value at all. A serious error on the part of the writer must therefore be confessed. How it came to be committed will probably be of interest to nobody.

Although the quite complete hind leg of *Allosaurus* on which Marsh based his restoration[2] is in the U. S. National Museum, the materials belonging to the fore leg, restored by Marsh on the plate cited, are not in that museum and I therefore do not know just what parts were in Marsh's possession. From his language we have the right to suppose that he had at least the scapula, the coracoid, the humerus and some claws.[3] These parts, then, ought to be available in making comparisons with corresponding parts of related dinosaurs. Further differences between *Allosaurus* and *Creosaurus* are said by Marsh[4] to be found in the elongated sacral vertebræ of the latter genus and the transverse processes, which are placed higher up on the centra than in *Allosaurus.*

It appears to the writer that some animadversions may justly be made on the methods of preparing restorations of fossil animals, both as shown in the scientific journals and as displayed in our museums. It seems incontestable that the public has a right to know on what materials all reconstructions, as well as

[1] *Proc. U. S. Nat. Museum,* XXXV., pp. 351–66.

[2] "Dinosaurs of North America," Pl. XII., fig. 2.

[3] *Amer. Jour. Sci.,* XXVII., 1884, p. 334, Pl. XII., fig. 1.

[4] *Amer. Jour. Sci.,* XVII., 1879, p. 91.

all conclusions, have been based. If the reconstruction of a skeleton or a part thereof is a graphic one those parts which are uncertain or missing ought to be indicated by the style of the drawing. As an example to be disapproved let us take Professor Marsh's restoration of *Camptosaurus dispar*. In his "Dinosaurs of North America," Plate LVI., the skeleton is represented as complete, except the front extremity of the hip bone and the tip of the lower jaw, the predentary. Nevertheless, according to Mr. C. W. Gilmore, who has recently studied all the materials,[5] it is found that the skull was missing (except perhaps the lower jaw), nearly all of the dorsal vertebræ, all of the tail, a part of the scapula, a part of the coracoid and all of the ribs. The skull shown in the restoration is evidently that of *C. medius;*[6] and this in its turn was, according to Gilmore, restored partly from probably another species, *C. amplus*. The restoration of the reptile would have been far more valuable had the doubtful and missing parts been so represented.

As regards the restoration of the skeletons of fossil animals for exhibition a few words may be said. Where the actual bones enter into the preparation their value may be impaired either through their being put into inaccessible positions or being partly covered with plaster. Sometimes a skeleton or a part may be mounted in a slab of plaster so as to show one side, naturally the best one. The investigator worthy the name will burn to see that hidden side. Hence, means should be sought for concealing as little as possible of the precious bones.

In mounts where original materials are used in connection with artificial substances the latter ought to be plainly distinguished from the former. It was a complaint of some of Marsh's assistants[7] that one would have to go over some mounts with a moist sponge in order to distinguish plaster from bone. The practise now in the museums may not be quite so bad, but Barbour's test has sometimes, at least, been made ineffective by the application of a coat of shellac. Too often the texture and the color of the bone is imitated very closely. Then the device of a thin red line between the bone and the plaster and that of a small red cross on whole restored bones are employed. These, however, are hardly visible at a distance and are not understood readily by the visitor; and they do not appear in photographs and reproductions of them. The writer believes that there ought to be a decided difference between the color of the bone and that of the plaster. It may be that the appearance of a great mammal or reptile thus mounted will be somewhat variegated, but equally variegated is probably also our knowledge; and beauty ought not to be secured at the expense of truth.

It frequently seems that the restoration of missing parts represents lost labor. In the United States National Museum is a large part of the skeleton of the extinct bird *Hesperornis* which was mounted by Mr. F. A. Lucas. For sufficient reasons the missing sternum was restored in plaster. The few cervical vertebræ preserved are shown in their place on a rod of metal. Nothing would have been gained by restoring the missing cervicals and the missing skull; especially since a drawing in the exhibition case shows the visitor the form of the whole bird. The example is to be commended.

The visiting public ought to be shown the reasons for each restoration that has been adopted; and this because of its educational value. If the hind leg of a great dinosaur is missing it may be restored from the other, but differently colored, and then labeled as missing in the specimen and reproduced from the one present. If both legs are wanting and are restored from the limbs of another individual or from those of a related species, this fact should be stated and the attention drawn to those real limbs, in case they are in the museum. The interest of the visitor will thus be excited, he will make the problem of the expert his own problem, and will pass judgment on the work done.

The plain indication of the restored parts of

[5] *Proc. U. S. Nat. Mus.*, XXXVI., 1909, p. 270.
[6] Marsh, *op. cit.*, Pl. LVIII.
[7] *Amer. Naturalist*, XXIV., p. 388.

fossil animals is likewise a matter of common honesty. Emperors, grand dukes and millionaires may found museums, and they secure recognition for their munificence; but right at hand are the masses of the people who, in the end, foot the bills, and they have also their rights. The declaration that all men are born free and equal was not a more important one and one perhaps not so wholly true as is a principle said to have been uttered by one of our senators during the debate on the pure food law: The buyer has a right to know what he is getting for his money. The principle applies in all walks of life, however much it may fret those who would secure wealth, position and honors disproportionate to their deserts. Applying it to museum administration, we may say that the visitor has a right to know whether he is gazing at real bone or at plaster, and the reasons therefor. Moreover, it is futile and mischievous to attempt to hide the nature of the restoring materials. It is sooner or later detected and suspicion is thrown on the whole exhibit.

It is the practise sometimes to build up a fossil skeleton out of the bones of various individuals. This can not be condemned in all cases, but usually it is dangerous. It may be permitted to make a skeleton of the extinct auk from as many individuals as there are bones. In the case of less well-known animals, represented probably by fewer bones there is likely to result a mixture of species and even of genera. And no hybrids are so fertile as these, inasmuch as they reproduce themselves throughout the world by means of the printing press. And these hybrids are monsters besides, having legs belonging perhaps to two or three distinct animals, the head to another and so on. Of these can we not say with Horace, who was describing[8] an object made up of members gathered here and there,

Spectatum admissi risum teneatis, amici?

And we may inquire if it advances science to send out over the world figures of an animal whose body belongs probably to one family and its head to another?

Rather than mingle the bones of several individuals belonging possibly to various species, it would be better to restore in plaster the various parts, except those of the principal individual, possibly of this also. Labels on the parts of the restored skeleton ought to direct the viewer to the bones, shown near by, on which the restorations have been based. As intimated, if visitors in the museums are not interested in plaster restorations and models it is probably because they believe that these things are products of the unchastened scientific imagination. There appears to be no other good reason why a plaster Megatherium should not be relatively as interesting as a plaster Venus of Milo. In these wholly artificial restorations the unknown parts should be as conscientiously indicated to the eye as in other cases.

And these plaster casts of the great animals that sojourned on the earth in bygone ages present another advantage that seems to be of the highest importance for the advancement of science. For now and anon some one among us, a paleontologist inchoate as yet but confident, the beneficiary of a favorable environment, bestriding his light-legged, straight-legged gypsiferous steed, perhaps *Brontodiplodococamarosaurus,* may gallop safely and merrily up the rugged slopes of the Mount of Fame.

OLIVER P. HAY

[8] "Epis. ad Pisones," I., 5.

SOCIETIES AND ACADEMIES

THE ACADEMY OF SCIENCE OF ST. LOUIS

THE Academy met at the Academy Building, 3817 Olive Street, Monday evening, April 19, 1909.

Dr. Robert J. Terry, of the Washington University Medical School, read a paper on "An Observation on the Development of the Vomer." The observations made on the development of the vomer in *Caluromys philaucler* affects the question of the homology of the mammalian vomer. Is the single vomer of mammals comparable with the single parasphenoid or the paired vomers of lower forms? Except in man the vomer of mammals has been found to arise from a single center. Lately, however, the bone in question has been seen to be accompanied by a parasphenoid ossification. It seems also to be the case in *Caluromys* that the origin of the base is paired.

Dr. Joseph Grindon then spoke on "The Protection against Disease afforded by Certain Substances in the Blood." The facts are apparent as soon as one approaches the study of the phenomena of disease. First, that the natural tendency of the body is toward cure. Second, that certain species and certain individuals are immune toward certain diseases. This immunity may be relative or absolute, temporary or permanent, natural or acquired. These two facts may be considered together, having much in common. The older theories of immunity are either untenable or incomplete. The modern view distinguishes between immunity towards poisons, and immunity toward the invasion of bacteria, which secrete these poisons. In discussing the immunity toward poisons Dr. Grindon reviewed the production of antitoxins naturally and artificially, dwelling particularly on the side-chain theory of antitoxins. In speaking of immunity toward bacterial invasion, the speaker explained the formation and function of agglutinins and coagulins. Bacteria as a rule do not thrive in bodies of living animals, because of the presence of substances inimical to them. These bodies are called lysins, and consist of two components—the amboceptor and tne complement. In concluding Dr. Grindon discussed phagocytosis and its application in practise.

The Academy met at the Academy Building on Monday evening, May 3, 1909.

Professor F. E. Nipher, of Washington University, presented a paper on "Lessons to be Learned from Common Things."

Professor Wm. Trelease, director of the Missouri Botanical Garden, presented, with numerous lantern slides, an oral abstract of a paper on the "Mexican Fiber Agaves" known as zapupe, in which botanical names and descriptions were applied to five new species of *Agave*, all of economic importance.

The secretary of the entomological section reported that at the March meeting Mr. Hermann Schwarz spoke on "Collecting in Mexico," illustrated with many views and insects from that locality. At the April meeting Mr. Philip Rau exhibited a number of golden rod galls together with one species of diptera and species of hymenoptera which had emerged from them. Professor J. F. Abbott lectured on "Collecting in Japan," illustrated with lantern slides and coleoptera collected by him.

The following resolution was adopted:

Realizing that the whole country is taking stock of the natural resources which remain, and believing that the conservation in particular of the forest and water resources of the state of Missouri are of particular interest to the people of this state; realizing furthermore that available statistics show that there has been a decrease of 29 per cent. in the amount of lumber produced in the state during the last ten years; realizing furthermore the importance of conserving the forest and water resources of the state not only from the standpoint of the timber to be actually used in building and other purposes, but also with a view that the conservation of the forests within the boundaries of the state is desirable in order that the water supplies may be conserved, the farming lands preserved in their integrity and opportunities preserved for recreation grounds for the people; realizing also that some twenty-four states have already taken advanced steps, looking toward the conservation of their forest and water resources, be it

Resolved, that the Academy of Science of St. Louis endorses the report made by the forest and water commissions to the governor, and endorses the bills now pending before the legislature of Missouri, looking toward the appointment of permanent forest and water commissions, and that copies of this resolution be sent to the governor and presiding officers of the senate and house of representatives.

W. E. McCourt,
Recording Secretary

THE AMERICAN CHEMICAL SOCIETY
NORTHEASTERN SECTION

The ninety-third regular meeting of the section was held at the Twentieth Century Club, Boston, on May 28. Dr. Willis R. Whitney, president of the society, addressed the section upon "Colloids and the Brownian Movement." The speaker pointed out many striking similarities between the properties of ions and of colloidal particles. He also presented two different theories to account for the "Brownian Movement." Dr. James F. Norris, of Simmons College, addressed the section upon "The Base-forming Properties of Carbon." The speaker presented the results already obtained in his study of the relation between the structure of the alcohols and their reactivity with aqueous solutions of the halogen acids, and showed the bearing of this work upon our knowledge of the mechanism of salt formations in general.

K. L. Mark,
Secretary